SPAWAR
Systems Center
San Diego

#C2-118

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Ciprofloxacin Resistance Associated with Marine Mammals

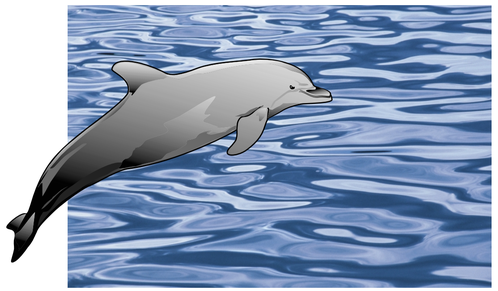
Abstract

Background: As part of the U.S. Navy Marine Mammal Program's vigilant preventive medicine program, antimicrobial susceptibility patterns of bacteria isolated from marine mammals have been closely monitored for greater than 20 years. Susceptibility patterns of bacteria to ciprofloxacin and their clinical significance to marine mammals were investigated.

Methods: From 1988 to 2001, 668 bacterial isolates identified from marine mammals (Atlantic bottlenose dolphins, Pacific bottlenose dolphins, Risso's dolphins, California sea lions, and a beluga) were submitted for ciprofloxacin susceptibility testing using NCCLS standards. Susceptiblity results were matched with animal treatment and clinical histories using SAS Release 8.2.

Results: Of 688 bacterial isolates identified from marine mammals, years 1988–2001, and tested for ciprofloxacin susceptibility, 17 (2.5%) were resistant. Resistant isolates originated from 10 marine mammals (eight Atlantic bottlenose dolphins and two Pacific bottlenose dolphins). Ciprofloxacin-resistant bacteria included *Enterococcus* sp. (1), *Escherichia coli* (2), *Pseudomonas* sp. (10), *Staphylococcus* sp. (2), *Streptococcus* sp. (1), and *Vibrio* sp. (1). Of animals with ciprofloxacin-resistant bacteria, five (50%) were female; the mean age of animals at isolate collection was 15.8 years (range 1.9–26.2). Sources of resistant isolates were peritoneal fluid (2), blowholes (14), and teeth (1). Of the 10 animals that cultured positive for ciprofloxacin-resistant bacteria, two (20%) had been treated with ciprofloxacin over the previous year, four (40%) had been treated with enfloxacin, and five (50%) had not been treated with any fluoroquinolone. Associated morbidity or mortality was limited to two animals, both with ciprofloxacin-resistant *E. coli* infection.

Conclusions: Ciprofloxacin resistance has been present in low numbers of bacteria isolated from marine mammals that have not been treated with with fluoroquinolones. In a few cases, these isolates may have been associated with mortality. The sources of ciprofloxacin-resistant bacteria, especially *E. coli*, need to be investigated further.



Introduction

The U.S. Navy Marine Mammal Program trains and cares for approximately 100 marine mammals. These animals live and work in the open-ocean environment, including San Diego Bay.

As part of the vigilant preventive medicine program at the Navy, marine mammal samples are often submitted for bacterial culture, characterization, and antimicrobial susceptibility testing. Microbial databases encompassing over 30 years of sample collection from marine mammals are stored as electronic records.

Due to the rising concern of antimicrobial-resistant bacteria, a retrospective, descriptive study was conducted using archived Navy data to assess the prevalence of ciprofloxacin-resistant bacteria identified from marine mammal samples, years 1988 to 2001.

Methods

Electronically archived microbiological records at the Navy's Marine Mammal Program were reviewed and analyzed using SAS Release 8.2. Analyses were conducted on all bacterial isolates tested for ciprofloxacin susceptibility from 1988 to 2001. All laboratories used by the Navy Marine Mammal Program reported adherence to NCCLS standards. Complete medication histories of all animals with ciprofloxacin-resistant samples were then reviewed.

Results

- Bacterial isolates tested, years 1988–2001: 688
- Bacterial isolates resistant to ciprofloxacin: 17 (2.5%)
  Ciprofloxacin-resistant bacteria: *Enterococcus* sp. (1), *Escherichia coli* (2), *Pseudomonas* sp. (10), *Staphylococcus* sp. (2), *Streptococcus* sp. (1), *Vibrio* sp. (1).
  Sources of ciprofloxacin-resistant bacteria: Blowholes (14), peritoneal fluid (2), and teeth (1).
- Marine mammals with ciprofloxacin-resistant bacteria: 10
  Species: 8 Atlantic bottlenose dolphins and 2 Pacific bottlenose dolphins
  Gender: 5 (50%) female
  Average age: 15.8 years (range 1.9–26.2)
  Treatment histories:
  2 (20%) treated with ciprofloxacin during the previous year
  4 (40%) treated with enfloxacin during the previous year
  5 (50%) not treated with any fluoroquinolones
  Morbidity: 2 (20%) animals with gastrointestinal disease, both with ciprofloxacin-resistant *E. coli* infection.

Discussion

Ciprofloxacin-resistant bacteria were identified in low numbers of a defined marine mammal population. Interestingly, half of the animals with ciprofloxacin-resistant bacteria had no history of treatment with any fluoroquinolones. Similar studies involving stranded marine mammal networks have reported isolation of antimicrobial-resistant organisms from wild marine mammals. How wild marine mammals acquire antimicrobial-resistant microbes is unknown.

Two isolates of *Escherichia coli* were resistant to ciprofloxacin; these isolates were identified 2 years apart from peritoneal fluid of two animals with similar clinical signs and outcomes. Most of the other ciprofloxacin-resistant microbes were from dolphin blowhole swabs, indicating that these organisms were present in the water and most likely did not infect the animals. Aside from *E. coli*, no other ciprofloxacin-resistant microbes had reported association with illness in marine mammals.

Conclusions

Marine mammals, including those not treated with antibiotics, can acquire antimicrobial-resistant microbes. These data indicate that marine mammals may serve as environmental sentinels for antimicrobial-resistant bacteria present in the ocean. To further understand the prevalence and role of antimicrobial-resistant bacteria related to marine mammals, the Navy is developing an active surveillance system to monitor susceptibility patterns of *Escherichia coli*, *Staphylococcus* spp., and *Vibrio* spp. isolated from marine mammals, ocean water, and food fish. Through such studies, the origin of antimicrobial-resistant microbes in the ocean will be investigated.

Ciprofloxacin-resistant *Escherichia coli* was associated with morbidity in two dolphins. Because the *E. coli* was not subtyped at the time of isolation, the true relationship between ciprofloxacin-resistant *E. coli* and illness is unknown. The Navy is currently testing fecal and blowhole samples from all dolphins to assess the prevalence of fluoroquinolone-resistant *Escherichia coli* in its total population.

SD 464, September 2002, SSC San Diego, 53560 Hull St., San Diego, CA 92152-5001
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